

# Characterization of Cadmium Health Risk, Concentrations and Ways to Minimize Residues in Shellfish



USDA Integrated Food Safety  
Initiative

Project Director's Meeting

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# Cadmium background

- Cadmium sources -- Natural and anthropogenic (batteries, fertilizers)
- Human exposure -- Smoking and food (lettuce, shellfish, liver)
- Impacts -- Respiratory & kidney diseases in humans, effects on shellfish are unknown
- The FAO/WHO PTWI (provisional tolerable weekly intake) -- 7  $\mu\text{g}$  Cd/kg of body weight from all sources

# Problem Identification

- Hong Kong and British Columbia -- 60% of samples over 2 ppm, mean 2.63 ppm
- Hong Kong and Hood Canal, WA -- Oysters ranged from 1.2-4.9 ppm, mean 2.9 ppm
- Codex Alimentarius Commission -- Deliberation of 1-ppm ML (maximum permitted level) for molluscan shellfish other than oysters
- International community -- EU - 1 ppm ML, HK - 2 ppm ML

# Project Sponsors & Partners

- USDA -- National Integrated Food Safety Initiative (funding)
- Graduate Women In Science (funding)
- Oregon State University – Seafoods Laboratory (project lead)
- Pacific Shellfish Institute
- Integral Consulting
- Hong Kong University of Science & Tech.
- Alaska Sea Grant
- California Sea Grant

# Research Goals

- Determine the spatial distribution of Cd concentration in shellfish harvested from west coast growing and harvest areas,
- Evaluate sources and factors that may influence shellfish Cd concentrations and uptake rates,
- Study Cd assimilation efficiencies, efflux rates and filtration rates in a controlled laboratory environment,
- Determine ways to minimize Cd residues in shellfish products, and
- Assess and explain impacts to the shellfish industry

# Introduction: Shellfish in Puget Sound

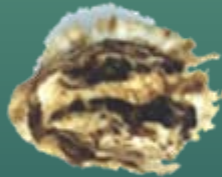
Pacific oyster



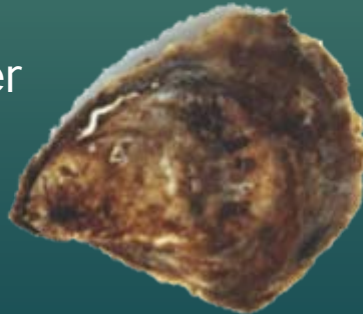
Manila clam



Kumamoto oyster



European oyster



Olympia oyster



Mussel



Geoduck





# Introduction: Shellfish Culture & Harvest



Intertidal bag culture of oysters



Oysters  
on a  
longline

# Introduction: Shellfish Culture & Harvest



Geoduck nursery tubes



Mussels  
suspended  
from raft  
units



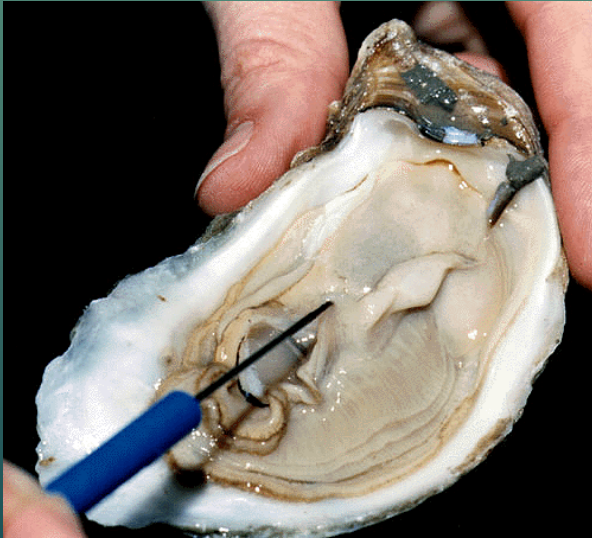
Mussel raft culture



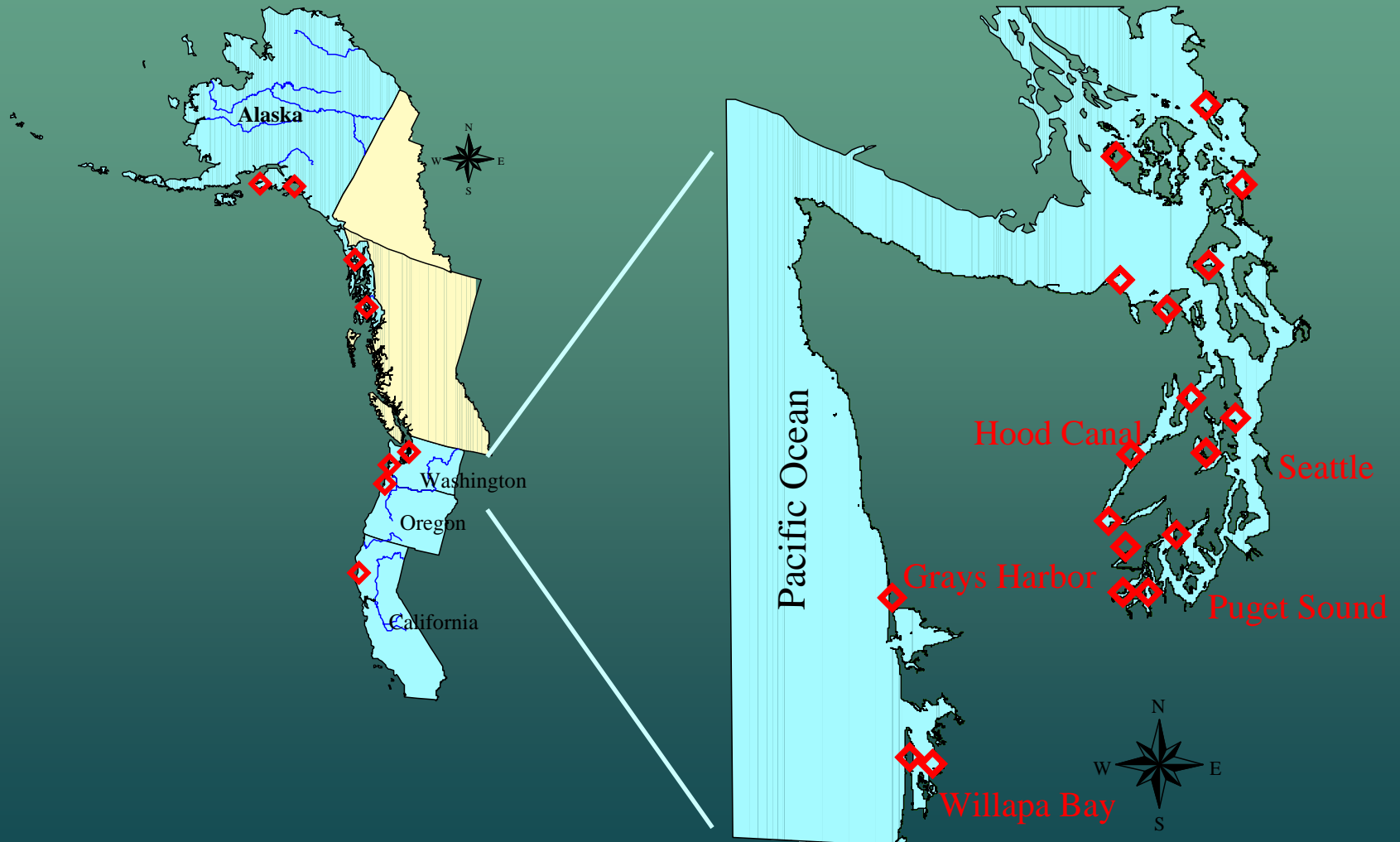
# Introduction: generalized responses

"On a warm summer day, an adult oyster sucks up and spits out up to fifty gallons of water over 24 hours, consuming plankton along the way. Three young oysters can match the filtering efficiency of one adult."

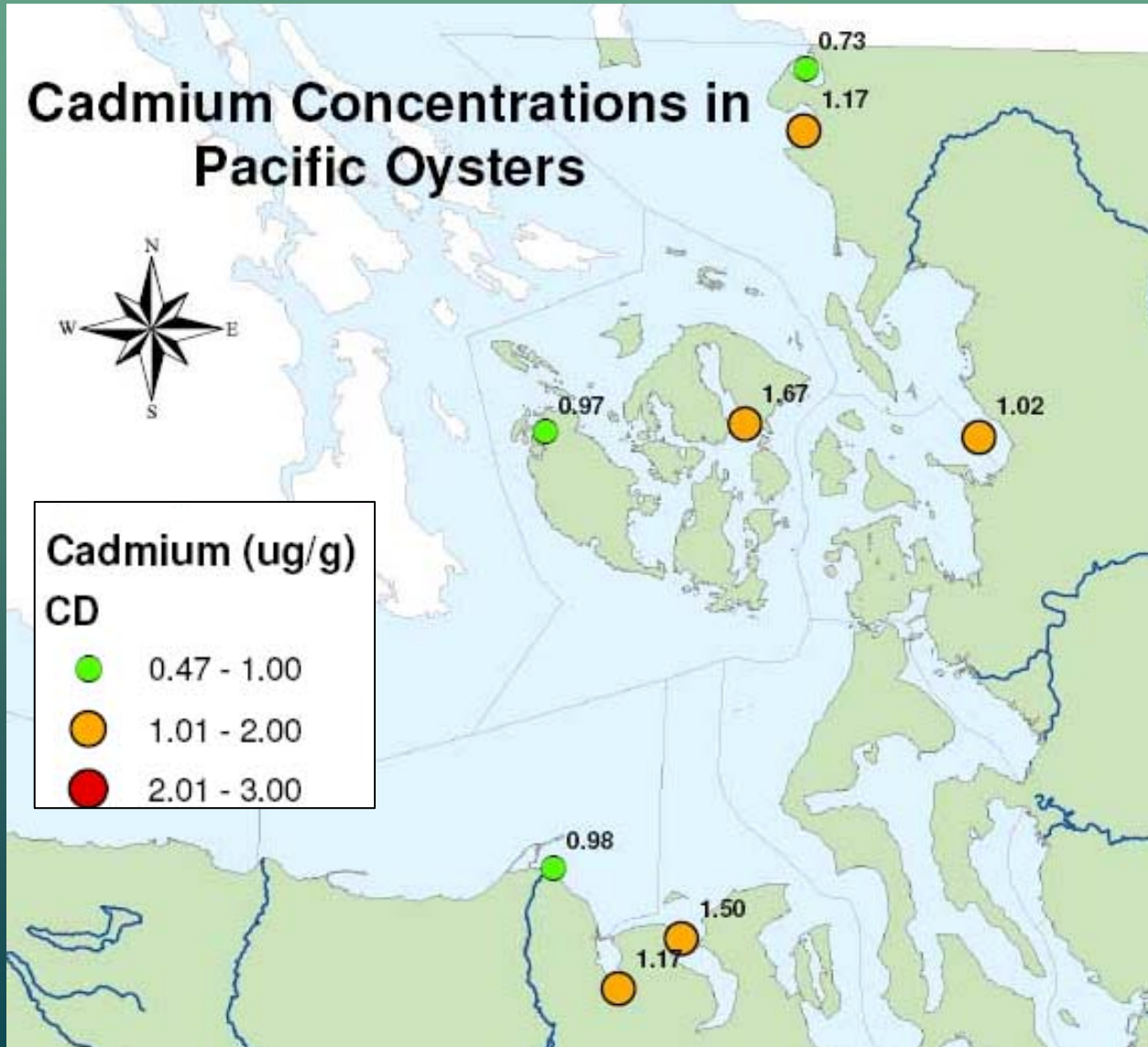
Roger Newell, The State of Oyster Disease: The Crucial Ecological Role of Oysters in Chesapeake Bay



# Sampling Locations

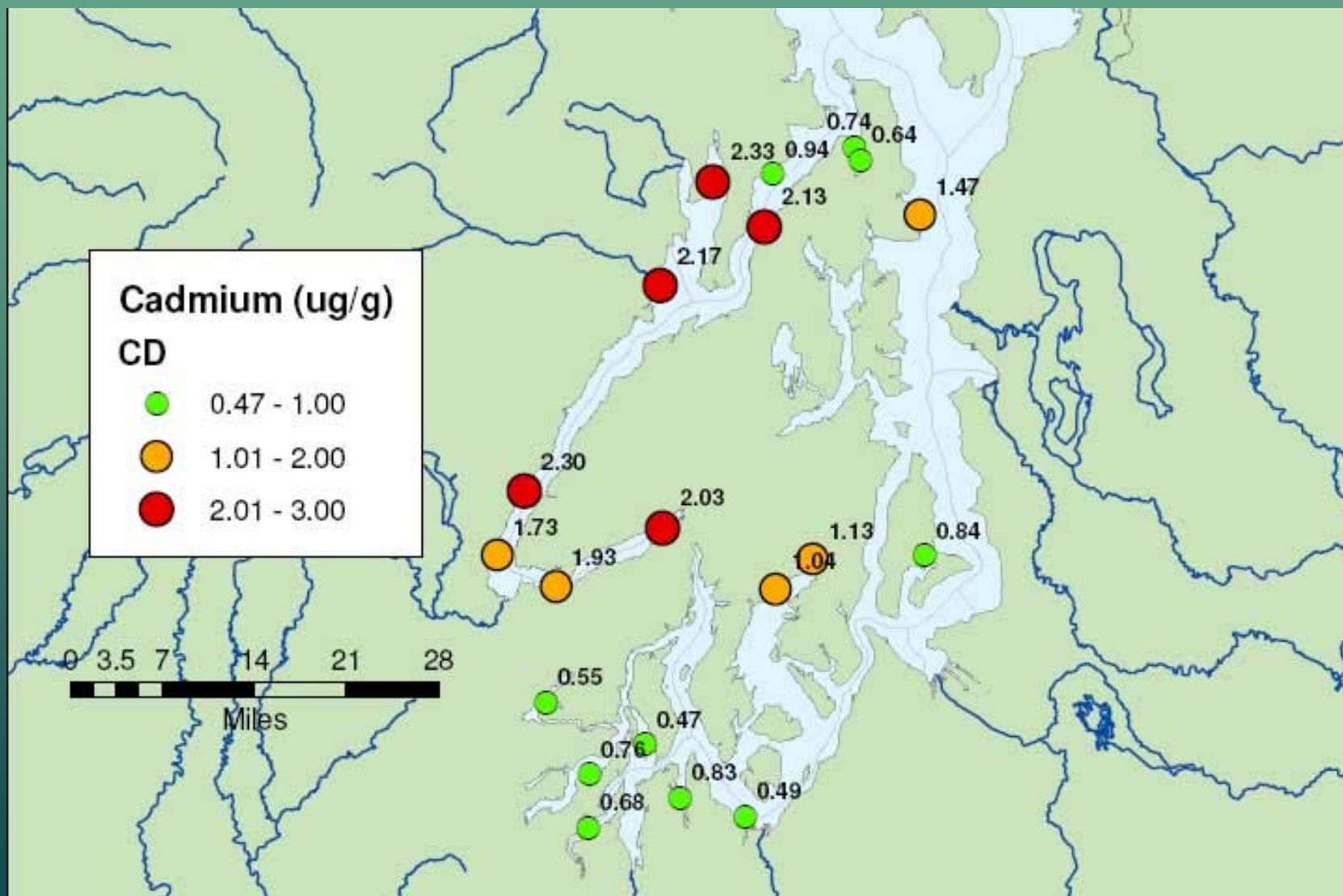


# Cadmium data



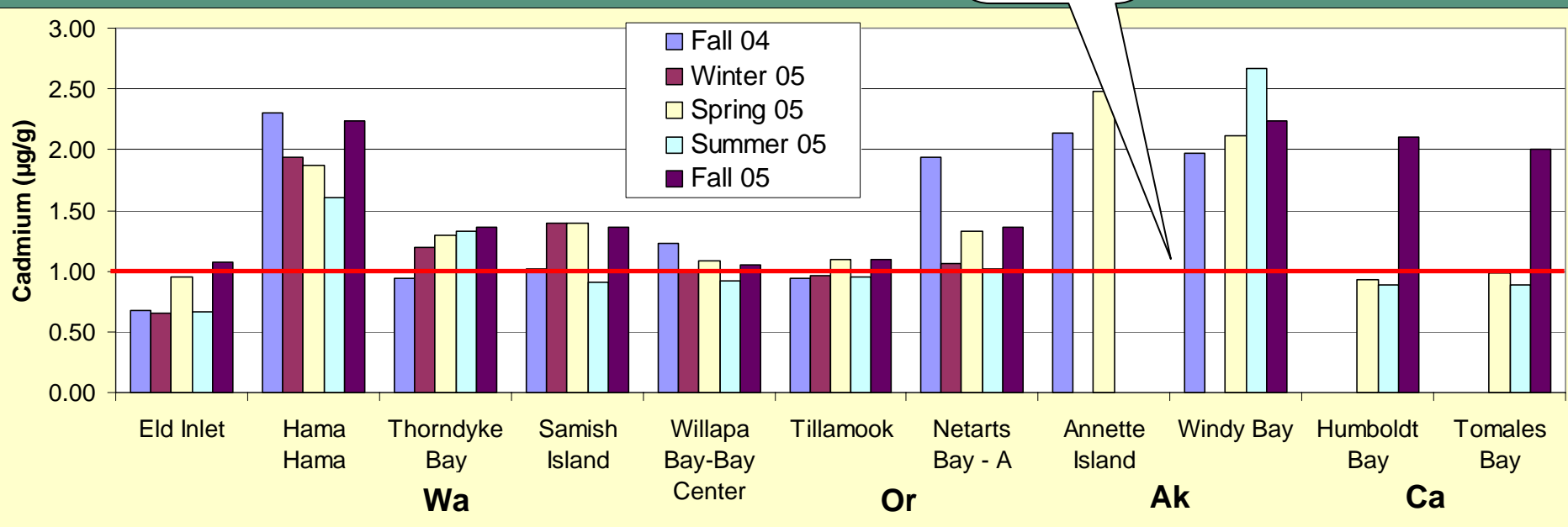
Distribution of cadmium in Puget Sound Pacific oysters

# Cadmium data



# Cadmium data

Average Seasonal Cadmium  
Levels ( $\mu\text{g/g}$  wet wt) in Oysters

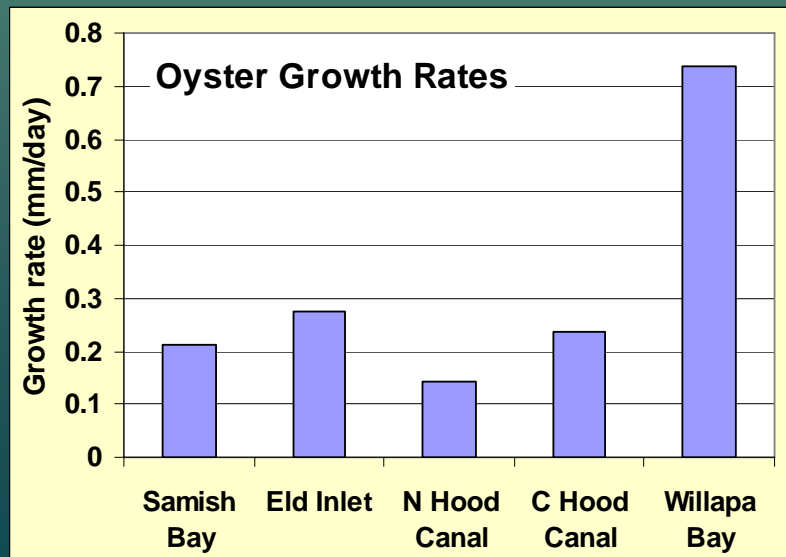
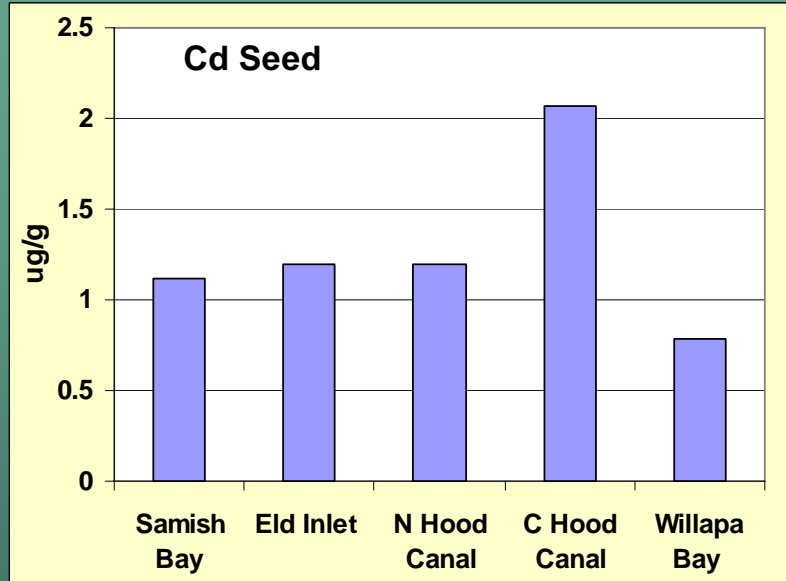




# Cadmium data

Apr to July 05 seed data

Assume Cd is lower in fast growing oysters: "The faster the growth rate, the shorter the amount of time spent accumulating Cd"



# Provisional cadmium field results

- Shellfish growing areas exhibit relatively consistent patterns of Cd enrichment.
- Tissue Cd levels seem to be more directly related to particulate Cd levels (phytoplankton?), rather than Cd dissolved in seawater or in sediments.
- There are no obvious industrial/Cd waste sources.
- Tissue concentrations may be influenced by factors that increase the rate of Cd uptake (temperature), other factors being evaluated.
- Tissue weight and growth rate may be important determinants of Cd levels.
- Cd in oyster tissues is only slowly depurated\*

\*Wen-Xion Wang, Department of Biology, HKUST, Kowloon, Hong Kong

# Provisional cadmium vs health

- Individuals that consume oysters and perhaps other shellfish at mean consumption rates and mean Cd concentrations remain below the PTWI
- Individuals may exceed the PTWI if they consume large amounts of oysters (90<sup>th</sup> %) and smoke, and/or if they consume greater than 6 oysters/wk at concentrations over 1.6 ppm (ns) and 1.3 ppm (s)
- While the health risks associated with ingesting Cd enriched shellfish remain to be assessed, evidence does indicate that Cd uptake will be enhanced in Native American, and Asian/Pacific Islander populations.
- Recent fish consumption surveys for west coast tribes indicate that individuals consume 10 times the amount of shellfish consumed by the average American in the 90% group.

# Provisional cadmium vs health

	Cd concentration (µg/g)	Cd ingested (µg)
Lowest regional mean	0.75	198
Highest regional mean	2.09	551
Average (all regions)	1.24	327
Maximum value	2.50	659
Hong Kong limit	2.00	527
CODEX proposed limit	1.00	263
<b>FAO/WHO PTWI</b>	<b>NA</b>	<b>420-490</b>
*Oyster weight of 43.9 g each is based on the mean weight measured in this study from all sites		

Cadmium intake based on the consumption of one meal of six oysters



